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Neuropsychological approach in the investigation of time perception in late life depression

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Abstract

Late life depression is characterized by changes in time perception which are connected with the state of higher mental functions and their neuropsychological correlates. To the investigation of these connections our study was dedicated.

A complex of methods included the Lurian neuropsychological diagnostics, prospective estimation of 5-, 10- and 15-second intervals and production of 1 min interval, retrospective estimation of the length of diagnostics and current time. Participants from control (n=26) and clinical (n=48) groups aged 50-81 were equal in socio-demographic characteristics. The interconnections between the characteristics of time perception and the different types of neuropsychological deficit as well as the characteristics of other higher mental functions were analyzed. With the purpose of the possibility of this multidimensional analysis the model of time perception was designed. The specifics of the inclusion and hierarchization of different components of the system with the purpose of achievement of adaptive result – time structuring of activity – was investigated. According to the hypotheses, in late life depression retrospective estimation deficit would be connected with memory deterioration, therefore, with dysfunction of deeper subcortical structures; the elaborated model of time perception was assumed to be useful in the analysis of time perception in its connection with other higher mental functions in old age. According to the results, in normal aging changes in time perception are connected with spatial deficit of memory, perception and praxis; in prospective judgments attention and control functions play a role. Time perception deficit is connected with dysfunction of deeper subcortical structures accenting in right hemisphere; prospective estimation – with prefrontal structures. In late life depression time perception deficit is connected with attention and control functions deficit; prospective judgments – with praxis; retrospective judgments – with memory deterioration. Prospective estimation deficit is connected with deficit in left-hemispheric structures and interhemispheric interaction; retrospective estimation deficit – with dysfunction of deeper subcortical structures. In different variants of aging tendencies to overestimation/underproduction of short intervals are connected with left-hemispheric dysfunction; to underestimation/overproduction – right-hemispheric dysfunction. Consequently, the hypotheses were approved and a full picture of interconnections between time perception and other functions and their neuropsychological correlates in late life depression was obtained. The proposed

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Received: 25 July 2018
Accepted: 9 August 2018
Published: 1 November 2018

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the Fifth International Luria Memorial Congress Conference Committee.

model of time perception was appropriate for analysis of time perception as it allows to reveal impaired the same as intact units of a functional system and to assume the primary or the secondary nature of impairments. The features of time perception interpreted based on the model may become the detectors of cognitive as well as affective dysfunction in old age.

Keywords: time perception, neuropsychology, gerontology, gerontopsychology, late life, depression, late life depression, higher mental functions, functional system, model of time perception.

1. Introduction

The number of elderly people in the population of different countries has grown recently [1]. Statistical data also indicates the growth of the frequency of mental disorders in old age, particularly depressions [2]. According to the data, the prevalence of depressions in late life is more than twice higher than in young and middle ages [3]; the frequency of the origin of depression in late life is 2-4% [4] while the frequency of the origin of depressive symptoms is 9-16,4% [5]. Nearly in 3/4 of all depressed patients the disorder origins starting from the age of 45–59 [6].

The interest of the scientists to cognitive impairment in late life depression is determined by their role in the chronification with deterioration of prognosis [3] and acceleration of the risk of the irreversible dementia [7]. It appears important to investigate cognitive changes in late life depression, particularly time perception changes, especially because one of the most widespread hypotheses of the etiology of depression is the hypothesis of desynchronosis, one of the main manifestations of which appear to be changes in time perception [8]. Evidences of the interaction between time perception and other mental functions determined the importance of the investigation of their interconnections which could lead to the building up of a full picture of cognitive functioning in normal and pathological aging [9].

2. Methodology

2.1. Participants

48 elderly depressed patients aged from 50 to 80 years old (clinical group) and 26 mentally healthy older adults aged from 50 to 81 years old (control group) took part in the experiment. All patients were under treatment in the Mental Health Research Center. Participants of both groups were equal regarding the main socio-demographic factors. Subjects with psychiatric disorders (except depression for the clinical group), neurodegenerative or other central nervous system disorders, oncological disorders in anamnesis, cognitive deterioration which could affect the task completion were excluded.

2.2. Material

A complex of methods included the full Lurian neuropsychological diagnostics [10], production of 1 min interval, prospective estimation of 5-, 10- and 15-second intervals and retest of estimation of 10-second interval, retrospective estimation of the duration of diagnostics and current time. Among the statistics procedures were used descriptive statistics, correlation analysis, Mann-Whitney U-test. The data of neuropsychological studies was first qualitatively processed.

2.3. Procedure

The participants were individually tested in the first part of the day: clinical group – in the cabinet of the clinical psychologist in the geriatric department of the Mental Health Research Center; control group – in a quiet room in a flat. The data collection took place between November 2011 and April 2014.

3. Results

3.1. Time perception characteristics in mentally healthy elderly people and in late life depression

In both groups were revealed tendencies to underproduction of a minute, overestimation of short time interval, underestimation of current time and duration of diagnostics, while in the group of elderly depressed patients they were more expressed (Figures 1,

2). Healthy controls tended to estimate more accurately the retest of the 10 s interval while in the clinical group indexes of accuracy of the first and the second estimations of a 10 s interval didn't differ (Figures 3,4).

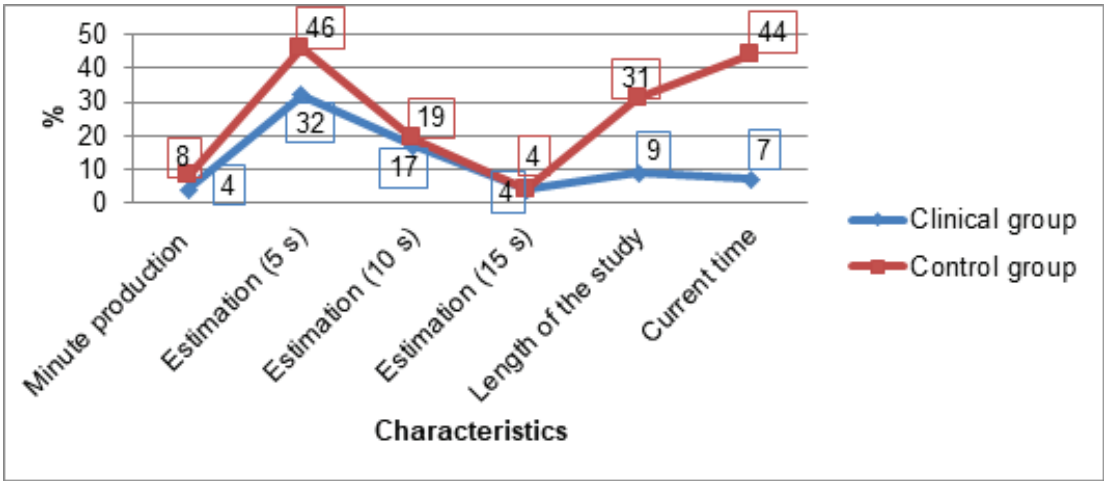


Figure 1: Mean values of the accuracy of estimation and production of time intervals of different duration in the control and the clinical groups (100% – all representatives of a corresponding group).

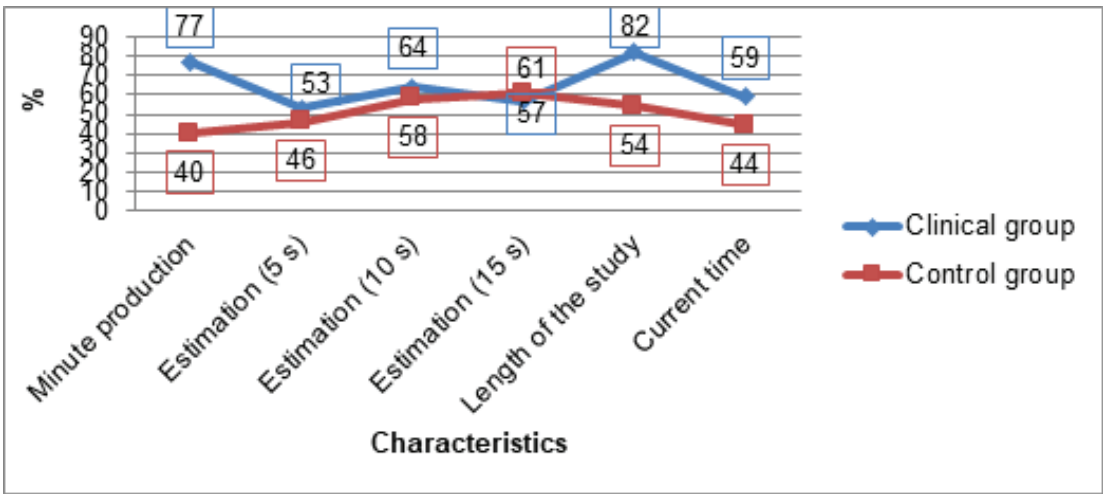


Figure 2: Pronouncedness of the "typical" tendencies to underproduction of a minute, overestimation of short time intervals and underproduction of the length of the study and current time in the control and the clinical groups (100% – all representatives of a corresponding group).

3.2. Interconnections between time perception and other higher mental functions

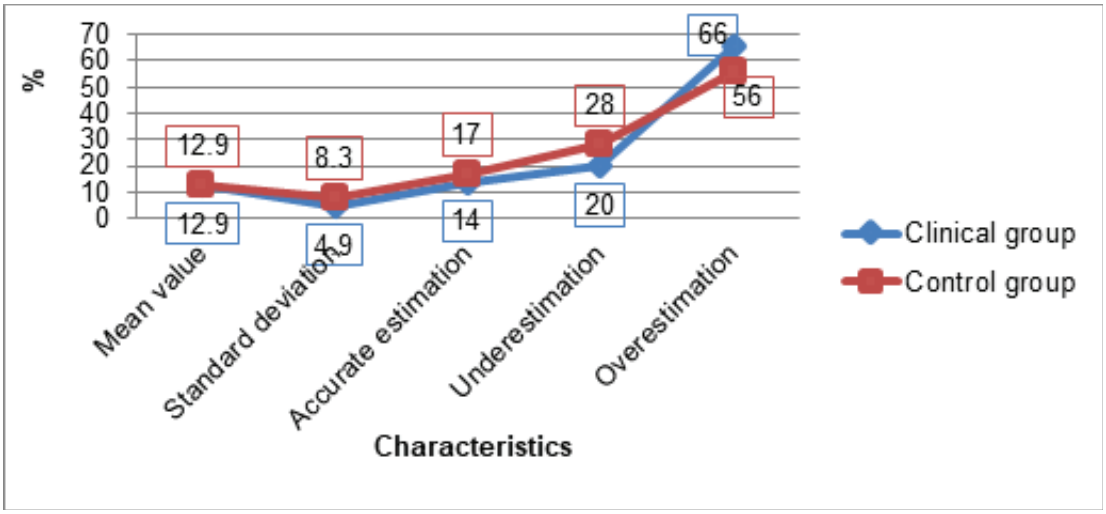


Figure 3: Parameters of the 1st esteem of a 10 s interval in the control and the clinical groups (100% – all representatives of a corresponding group).

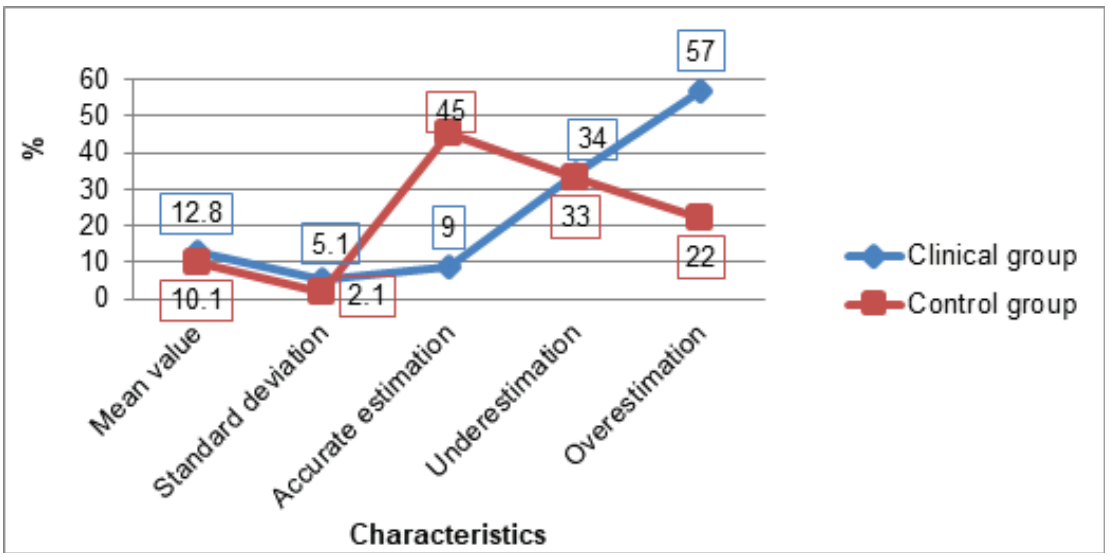


Figure 4: Parameters of the second esteem of a 10 s interval in the control and the clinical groups (100% – all representatives of a corresponding group).

3.2.1. Interconnections between time perception and other higher mental functions in mentally healthy elderly people

In the control group the deterioration of accuracy of one minute production corresponded to the acceleration of the number of spatial errors in different neuropsychological tests; its underproduction – to the deterioration of the performance of reciprocal coordination, acceleration of the time of search of numbers in the Schulte tables, deficit of auditory-speech memory. Mistakes in consequence of right hemispheric deficit corresponded to one minute overproduction, left hemispheric – underproduction. Accurate one minute production corresponded only to the absence of memory impairment.

Deterioration of accuracy of short intervals estimation appeared to be connected to spatial deficit in different tests as well as the tendency to fatigability in Schulte tables and visual-spatial memory. Difficulties in choice reaction corresponded to the lack of coincidence of the marks of estimation of two 10 s intervals; "mirror" mistakes in Head tests – to underestimation of short time intervals. Growth of accuracy of estimation of the duration of diagnostics corresponded to the better execution of the test "silent clock", deterioration of a number of "mirror" mistakes in Head tests and form distortions in the test on visual-spatial memory.

3.2.2. Interconnections between time perception and other higher mental functions in late life depression

Underproduction and deterioration of accuracy of one minute production corresponded to deterioration in simple rhythms estimation and time identification on "silent clock". Deterioration of accuracy of one minute production corresponded to deterioration of kinesthetic praxis execution, lowering of productivity of immediate reproduction of words and figures. Underproduction of one minute was connected to auditory-speech memory impairment.

Overestimation of short time intervals appeared to be connected to acceleration of a number of spatial mistakes in Head tests and time identification on "silent clock", with lowering of productivity of auditory-speech and visual-spatial memory. Low accuracy and tendency to overestimation of time intervals corresponded to spatial deficit in the clock drawing as well as deterioration in rhythms estimation, praxis of the pose of fingers, dynamic praxis, choice reaction and bilateral poses in Head tests. Mistakes in unilateral poses in Head tests corresponded to underestimation of short intervals. Lowering of accuracy of short intervals estimation was connected to deterioration of execution of reciprocal coordination, "mirror" mistakes in Head tests, tendencies to fatigability and warming-up in Schulte tables. Overestimation of a 10 s interval both in the first and in the second presentations corresponded to the acceleration in the number of mistakes in proper order of words in auditory-speech memory and modality-nonspecific memory impairment. The lack of coincidence of the marks of estimation of 10 s intervals was connected to auditory-speech memory deficit.

Lowering of accuracy of estimation of the duration of diagnostics corresponded to deterioration of the clock drawing and choice reaction execution as well as with the acceleration of a number of spatial mistakes in dynamic praxis and Head tests, admission of words and figures, acceleration of cases of changing of the order of

figures in the visual-spatial memory test. Underestimation of the duration of the diagnostics corresponded to acceleration of the number of mistakes in the "silent clock" test, words admission in the auditory-speech memory test, tendency to fatigability in Schulte tables.

Deterioration of the accuracy of current time estimation appeared to be connected to acceleration of the search time in Schulte tables as well as with deterioration of involuntary text memorization; acceleration of a number of cases of words and figures admission in memory tests; acceleration of a number of mistakes in consequence of adding of unnecessary details, order changes and turning of figures in the visual-spatial memory test; lowering of productivity of immediate reproduction in memory tests. The tendency to overestimation of current time corresponded to deterioration of a number of correctly reproduced words in a delayed reproduction.

3.2.3. Interconnections between time perception and different types of neuropsychological pattern in late life depression

In the basis of a typology of neuropsychological profiles was put the localization of brain dysfunction connected with one of another deficit in mental activity. First, there were distinguished 4 sub-groups: 1) with a major deficit of median deeper subcortical brain structures (37% clinical, 5% controls); 2) with the combination of the dysfunction of the same structures and frontal divisions (34% clinical; 45% controls); 3) with the combination of the dysfunction of the same structures and dorsal divisions (11% clinical; 25% controls); 4) with the deficit of median deeper subcortical brain structures, front and dorsal divisions (18% clinical; 25% controls).

In the control group the representatives of the second sub-group turned out to be less accurate in the retest of a 10 s interval than the representatives of the fourth sub-group.

In the clinical group the representatives of the first sub-group turned out to be less disposed to overestimation of short time intervals than the representatives of the second and the third sub-groups; the representatives of the first sub-group were less accurate in short intervals estimation than the ones of the second sub-group but more accurate than the ones from the third sub-group. The representatives of the fourth sub-group were less disposed to overestimation of short time intervals than the ones of the second and the third sub-groups and were less accurate than the ones from the second sub-group. The most expressed overestimation and the least accurate estimation of the 5 s interval was revealed in the third sub-group. The accuracy of the

first estimation of a 10 s interval was the highest in the second sub-group and the lowest in the first sub-group; the reverse results were obtained for the retest of a 10 s interval for these sub-groups.

We also distinguished the sub-groups with different types of brain deficit according to the hemispheric presence of symptomatology: with the predominance of 1) right-; 2) left- and 3) not connected with the hemispheric deficit symptomatology.

In the control group the representatives of the second sub-group were disposed to minute underestimation, the ones of the first and the third sub-groups – to minute overestimation.

In the clinical group the representatives of the third sub-group were less accurate in the estimation of the duration of the diagnostics than the ones of the second sub-group.

3.2.4. Elaboration of the model of time perception as a functional system

Difficulties in the definition of the subject of time perception determines its investigation in the connection with other mental functions/ In the aim of it complex study I've developed the model of time perception in the framework of a system dynamic approach in psychology based on the theory of functional systems of P.K. Anokhin [11] and the tradition of the application of the concept of functional system to the analysis of mental functions (A.R. Luria [10], Yu.V. Mikadze [12] etc. We analyze the psychological intention of the concept of time perception, the way it realizes in the actual action of a person, in other words we study the psychological system of time perception.

The result of time perception appears to be the structuring of one's activity in time which is necessary for adaptation to the environment. In each situation the reach of the adaptive result becomes apparent in a concrete aim: making work by deadline, coming in time to the airport, and so on. The process is initiated by a triggering stimulus, like the signal of a stop-watch or a decision-making of the start of some activity, which is "noised" by some extra afferent information (time of the day, time of the year, existence or absence of jet-lag). Time perception has a basis in genetic apparatus, relies on biorhythmic brain activity. It is connected with other mental functions, for example memory: for the estimation of the interval we draw out from memory the information about the standards of duration, time units, experience of the estimation of the duration of some actions during the lifetime (about the duration of working day,

lunch break, etc.). Many studies have shown the connection of time perception connection with perception in other modalities, like auditory and visual. Time perception is based on actual motivation (particularly, expertise motivation), depends on emotional state (for example, existence or absence of anxiety). Time perception is also connected with regulatory functions, presumes the anticipation of the result of the action (units "action program" and "the acceptor of the results of the action"). The result of time estimation depending on its accuracy and the achievement of the result leads to the completion of the process or it reconstruction. The functional system is characterized by dynamism in actual situation (changes in motivation, emotional state, attention fluctuations) as well as along the lifespan (development of the system of the tools of symbolic mediation, change in the accessibility of past experience depending on memory changes and others).

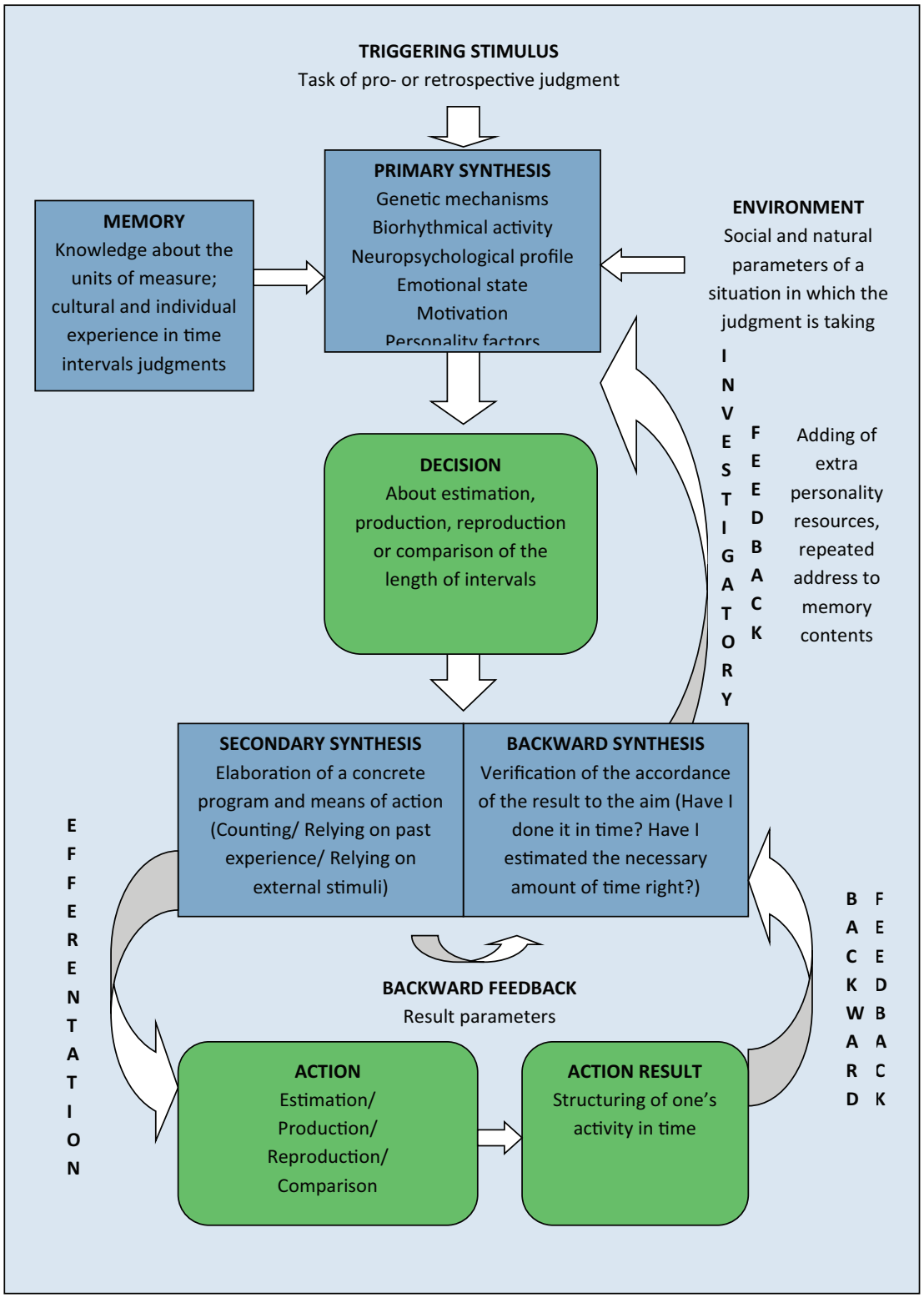
4. Discussion

Time perception in mentally healthy elderly people and late life depression

In normal aging participants managed the best the production of a standard time interval – minute. They were more accurate in the estimation of longer and filled time intervals in comparison with short and empty which may tell us about the importance of the usage of personal life experience on time estimation. Depressed people showed the tendency to the lowering of accuracy of time judgments, especially retrospective ones, and the last were not more accurately estimated than the prospective ones which we explain by the difficulties in the address to time standards kept in memory.

If we have an overall look at the tendencies characteristic for the groups, we'll see that the tendencies themselves were equal but they were more expressed in the clinical group. The characteristics of the esteems of short and empty in comparison with long and filled intervals meets the rule of time esteems by S.L. Rubinshtein [13]: the first are overestimated, the last are underestimated. Interesting results were obtained concerning the estimation of a 10 s interval and the retest of this estimation. While in the first test the results were equal in both groups – in the second we see vivid differences: significant increase in the accuracy in the control group and no change in the clinical group. It may indicate bigger rigidity of time esteems in the clinical group, its connection with regulatory deficit which will be more evident in the analysis of the results of neuropsychological study.

On the whole, normal aging is characterized by retrospective underestimation of long intervals, prospective overestimation of short intervals and underproduction of



Psychological model of time perspective as a functional system

Figure 5: Psychological model of timing as a functional system.

subjective minute. Late life depression is characterized by sharpening of some characteristics of time perception typical for normal aging, which relates to the tendencies

in time perception, but also disorganization in some aspects of time perception, which relates to the lowering of the accuracy of time esteems, especially in retrospective judgments.

4.1. Interconnections between time perception and other higher mental functions in mentally healthy elderly people and late life depression

The results of the control group indicate the existence of the link between changes in the estimation of different time intervals in old age and the spatial deficit of activity, particularly the deficit of perceptual-spatial memory, which confirms the idea of the link between time and space perception in normal state and indicates the role of mediation in the ensuring of productive time esteems. In prospective judgments the attention concentration, the regulation and control of activity obtained significance. It confirms the assumption about the role of special "time" attention in time perception, the difficulties in the concentration of which are linked to the dysfunction of right hemispheric structures [9]. In the control group the prospective estimation and the production of short time intervals were in a higher degree connected with other higher mental functions than the retrospective estimation of longer intervals, which means a lower dependence of retrospective judgments on the brain maintenance of mental activity. It is very likely explained by the role of the usage of past experience in the estimation of longer time intervals, like during work or discharging some daily duties.

In late life depression the estimation and the production of short time intervals were to a greater extent connected with the state of different components of praxis; estimation of longer intervals – with the state of memory and attention. Probably, the deficit of efferent units of the ensuring of time perception in prospective esteems and difficulties in addressing the content of memory in retrospective judgments appear to be more significant in late life depression. In pathological aging, on one hand, increases the role of nonspesific deeper brain structures in the overall decrease in the productivity of time esteems and the aggravation of the tendency to a speeded-up perception of time; on the other hand, the role of hemispheric subcortical structures and the interaction between them in harmonization of the process of time perception. One of the most significant factors in the decrease in accuracy of time esteems becomes the increase of interdependency of mental functions, when the deficit in one of the units of a functional system contributes to the involving of other units in the process of negative changes. The revealed in both groups connection between regulation deficit

and the disbalance of time esteems supports the assumption about its role in the formation of the action program and the further checking of the results with the needed parameters.

4.2. Elaboration of the model of time perception as a functional system

The presented model of time perception corresponds to the aims of the investigation of time perception in late life depression because it provides a possibility of a complex analysis of affective and cognitive indexes and a factor of brain functioning; to register the changes in the results of actions (for example in the first and the second esteems of a 10 s interval).

The model is appropriate for the analysis of the overall process of time perception as it lets indicate the disturbed as well as undamaged units of a functional system, to assume the primary or the secondary status of a disturbance which matches with the principles of syndrome analysis in psychology presented by L.S. Vygotsky, A.R. Luria and others.

5. Conclusions

The hypotheses were approved and a full picture of interconnections between time perception and other functions and their neuropsychological correlates in late life depression was obtained. In different variants of aging tendencies to overestimation/underproduction of short intervals are connected with left-hemispheric dysfunction; to underestimation/overproduction – right-hemispheric dysfunction. In normal aging changes in time perception are connected with spatial deficit of memory, perception and praxis; in prospective judgments attention and control functions play a role. Time perception deficit is connected with dysfunction of deeper subcortical structures accenting in right hemisphere; prospective estimation – with prefrontal structures. In late life depression time perception deficit is connected with attention and control functions deficit; prospective judgments – with praxis; retrospective judgments – with memory deterioration. Prospective estimation deficit is connected with deficit in left-hemispheric structures and interhemispheric interaction; retrospective estimation deficit – with dysfunction of deeper subcortical structures. The proposed model of time perception was appropriate for multidimensional analysis of time perception in its connection with other higher mental functions.

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